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Analysis of British Wartime Reports on Hours of Work

as Related to

Output and Fatigue

Number 2
November, 1917

National Industrial
Conference Board

National Industrial Conference Board

15 BEACON STREET, BOSTON, MASS.

THE National Industrial Conference Board is a co-operative body composed of representatives of national industrial associations, and organized to provide a clearing house of information, a forum for constructive discussion, and machinery for co-operative action on matters that vitally affect the industrial development of the nation.

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ANALYSIS OF BRITISH WARTIME REPORTS ON HOURS OF WORK AS RELATED TO OUTPUT AND FATIGUE

NUMBER 2

NOVEMBER, 1917

NATIONAL INDUSTRIAL CONFERENCE BOARD
15 BEACON STREET
BOSTON, MASS.

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Foreword

THE National Industrial Conference Board, as a part of its research activities, is now investigating the relation of hours of labor to industrial efficiency, having special reference to the health and safety as well as to the output of workers.

Pending completion of this study, and because of the timeliness and importance of the experience of Great Britain with the hours-of-labor problem, the Board deems it advisable to publish the accompanying analysis of reports of certain British commissions and investigators on the efficiency and health of industrial workers under wartime conditions. This is done as a matter of information, and not to set forth conclusions. While the analysis is intended to be critical, the Board has sought to avoid all expressions of opinion which might anticipate or prejudice the results of the broader inquiry now in progress.

Analysis of British Wartime Reports on Hours of Work as Related to Output and Fatigue

SUMMARY

Immediately after the outbreak of war, in 1914, laws and customs governing hours of work in British munition factories were generally abrogated. The work-week was lengthened until 80, 90 and even 100 hours became common. Sunday labor was the rule. Widespread discontent among workers, evidence of excessive fatigue, and a continued shortage of product led the British Ministry of Munitions, in September, 1915, to appoint a Health of Munition Workers Committee to investigate the relation of the length of the workday to the health and output of the workers. Similar investigations were also undertaken in behalf of the Government by other agencies.

These investigations are still in progress, but a number of preliminary reports have been published, of which those of the Health of Munition Workers Committee are the most important. The principal output studies of the committee were conducted by Dr. H. M. Vernon, of Magdalen College, Oxford. They comprise an analysis of the output of groups of workers engaged in different kinds of labor under different hours-of-work schedules. Four of them covered a period of from twelve to thirteen and a half months.

While it would appear that the committee was in general sympathy with Dr.Vernon's work it did not specifically commit itself to an endorsement of his conclusions.

Dr. Vernon's reports definitely indicate that exceptionally long work schedules are uneconomic. Output from 70 or more *actual* hours of work per week was, in almost every case, less than that subsequently obtained under much shorter hours.

For certain heavy labor performed by men, involving considerable hand work, the reports show that maximum output was secured from about 51 *actual* hours per week.

For certain moderately heavy labor, performed by women, they show that maximum output was secured from about 55 *actual* hours per week, and they indicate that somewhat shorter hours would have yielded equal production.

For certain lighter work, chiefly of the machine type, performed by women, they show that 55 *actual* hours of work per week maintained maximum output; Dr. Vernon contended that a moderate further reduction in hours would not involve a serious decrease in product.

For still lighter machine work, performed by boys, they show that with 55 *actual* hours of work per week, output was about 4% less than the maximum obtained in 69 hours and that a further reduction of hours involved a marked loss.

The distinction between *actual* and *nominal* hours must be fully appreciated. *Nominal* hours were the factory's official schedule; *actual* hours were the hours actually worked, after deducting from *nominal* hours the time lost because of absences, tardiness, and minor interruptions of work. The nominal hours usually were much longer than the actual hours and there was no constant relationship between them. Therefore if results obtained under actual hours are to be used as a basis for changing nominal hours, proper allowance must be made for this widely varying differential.

Moreover, because of the abnormal circumstances under which the studies were made, and an absence of full information as to collateral conditions, the findings cannot be accepted as conclusive even when related to actual hours.

The value of the studies lies in broad suggestion rather than in quantitative result. They indicate that reduction in work hours within certain limits does not necessarily decrease output, but on the contrary may, for some classes of labor, actually increase it. But they cannot be regarded as establishing the precise number of hours in which maximum product can be secured. Before arriving at specific, or even approximate, conclusions on this point it is essential to have a much broader basis of observation under normal conditions.

Indeed, the very nature of the hours-of-work problem is such that no rigid rule of universal application can be laid down. Final deductions can be arrived at only after a mass of experience has been carefully assembled and analyzed. The British reports here reviewed are merely a contribution to the larger evidence required for definite judgment.

Since the studies were conducted in the midst of the stress and strain of war, patriotism may have exerted an important influence. Wages were high and generally on a piece-rate basis. The Government, in March, 1915, gave the workers its pledge that such piece-rates would not be reduced. The report states: "There was every possible stimulus for them to exert their maximum powers of production." Obviously, results secured under such incentives may not be fairly representative of those obtainable under ordinary conditions.

Again, reduction in work hours was largely due to the abolition of Sunday labor and the effect on output may have been greater than that of an equal reduction spread over the week where there was no Sunday work. Excessive hours and long-continued Sunday labor may have resulted in an abnormally low rate of production at the time the studies were commenced; if so, subsequent increases in output under shorter hours would thus be exaggerated.

Still again, output during the early course of the studies may have been deliberately restricted. It is a matter of general knowledge that, prior to the outbreak of the war, restrictive rules and customs were practically universal in British industries. It is impossible to say how far this attitude may have been modified during the war by patriotism or by higher wages. Continued existence of restriction was charged by some British critics, although this charge was discredited by Dr. Vernon.

Moreover, acceptance by organized labor, for the period of the war, of the employment of unskilled labor on skilled work, and of women, has had the practical effect of changing the British munitions industry from a closed-shop to an open-shop basis. This change was, of course, accompanied by an enormous increase in the total production of munitions in Great Britain. To what extent it contributed to an increase in individual efficiency of workers cannot be determined from the reports here analyzed.

Since many of the workers observed in the course of the studies had previously had no technical experience it might seem that increases in output could be ascribed to increasing proficiency, but Dr. Vernon stated that "the data were so chosen as to eliminate any possible disturbances due to increasing skill." His method was to use results for only such workers as had attained what he considered maximum efficiency.

The reports further state that "in none of the operations studied was there any change either in the nature of the operation or of the type of machinery during the period under notice."

To some of Dr. Vernon's specific conclusions it is necessary to take definite exception. For instance, he argued that for women engaged in moderately heavy labor a 50-hour *nominal* work-week should yield substantially maximum output. As this contention was based on observations covering only a few weeks during which the rate of output was exceptionally high, it does not appear to be justified.

Yet, despite abnormal conditions, the limited scope of the data, and a lack of further collateral information, the reports are worthy of serious attention as suggesting possibilities of readjustments mutually advantageous to employer and employee. They indicate the desirability of further scientific study of the length of the workday in its effect on production, particularly where conditions are normal and where collateral influences can be more definitely ascertained.

Some of the British reports have been quoted to prove that an eight-hour day is more productive than a longer workday. Such inferences are not justified. The merits of an eight-hour day are not really discussed in the reports. Although some favorable references are made to eight-hour shifts in continuous industries, the Health of Munition Workers Committee states that it did not consider the eight-hour-day issue a part of its problem. In practically every instance when *actual* hours of work per week fell below 48 (the latter being considerably in excess of the actual hours to be expected under a nominal

48-hour week) a significant loss in output is indicated. But the evidence on this subject in the reports is too meager and incidental to warrant conclusions.

The reports have sometimes been so quoted as to give the impression that workers in British munition factories were steadily breaking down under the strain of long hours. The reports do not support this assertion. On the whole, after the extremely long work-week early in the war was somewhat shortened, the health of British munition workers was surprisingly well maintained under work schedules that were still unusually long. Nearly all the investigators report a better general state of health and less evidence of fatigue than had been expected. This applies to women as well as to men. A committee of women physicians, who supervised the examination of female workers, reported that most of the medical inspectors were "agreeably surprised" at the results. It was generally contended that these favorable health conditions were partly due to a better scale of living, made possible by relatively high wages. The same hours under low wages, with no special incentive, might have given widely different results.

The output studies were essentially studies in fatigue. The Health of Munition Workers Committee regarded output as the best test of fatigue, which was described as "the sum of the results of activity which show themselves in a diminished capacity for doing work."

Physical sensations were pronounced to be very unreliable as an indication of the extent of fatigue, since fatigue has its origin in the nervous system rather than in the muscles, and is now often held to be due to generation of poisonous substances in the blood and tissues. Fatigue was likened, not "to the failure of fuel in a steam-engine," but "to the clogging of the wheels of some mechanism by dirt."

Practically all of the British reports emphasize the importance of rest periods within the workday. Considerable evidence is presented to show that, by checking fatigue, rest periods may increase total output. To obtain the full benefit of such pauses it is regarded by some of the investigators as essential that they be carefully systematized and not left to the worker's inclination.

The committee reported strongly against Sunday labor. It found that a seven-day work-week was prejudicial to health and did not increase output. Most employers were reported to be opposed to Sunday work.

The committee also laid great stress on the value of holidays.

Overtime as a regular practice was regarded as objectionable and unprofitable, and the committee urged that overtime should not be employed on consecutive days, or in connection with Sunday work. It would seem clear, however, that objections to overtime must depend somewhat on the length of the workday.

The reports made to the British Home Office by Professor A. F. Stanley Kent appear to be of little assistance in a study of the hours-of-work problem. In most cases they relate only to small groups of workers and brief periods of time. In fact, one of his principal comparisons, which has been widely quoted in support of an eight-hour workday, contrasted the output of only a single worker with that of three others over a period of but a few weeks. Moreover, his report indicates that this eight-hour worker was exceptionally proficient and that she had more assistance than the other three. Such conditions invalidate the test; and in any case, such limited data would not afford a proper basis for broad conclusions. Serious statistical errors further impair the scientific value of his work.

While therefore the report of Professor Kent should be disregarded, those of the Health of Munition Workers Committee are a noteworthy contribution to the scientific discussion of the subject. They suggest certain broad principles of the hours-of-work problem, to be carefully considered in further study, viz.:

> That the proper length of the workday depends considerably on the character of the work. This principle is not new, but has not been sufficiently recognized.
>
> That, at least in certain kinds of heavy work, women cannot endure as long a workday as men. With this qualification, the studies indicate that women can safely do many kinds of work which hitherto have been regarded suitable only for men.

That experience with rest periods has been sufficiently encouraging to call for further consideration and experiment.

That wages and systems of wage payment have an important bearing on output.

It is important to bear in mind that British industrial experience under war conditions cannot consistently be applied to the United States, either in times of war or peace, unless allowance is made for differences in industrial conditions in the two countries. *Nominal* work hours in American industries are frequently shorter than even the reduced *actual* work hours reported in some of the British studies. Moreover, the same nominal schedules often result in different actual hours in the two countries. Differences in factory and home conditions, in speed of machinery, in wage rates and systems, in trade practices, and other factors, must also be considered before attempting to apply British experience and conclusions to American industries.

PRELIMINARY REPORTS OF HEALTH OF MUNITION WORKERS COMMITTEE

The reports of the Health of Munition Workers Committee are the only ones extensively discussed in this analysis. Up to the present time the committee has issued eighteen memoranda and one interim report dealing with fatigue, output, health of workers, ventilation, canteens, nutrition, and various other matters.[1] Only those portions of the reports bearing directly on the relation between hours of work and the health and efficiency of workers are herein considered.

Other wartime studies of the problem, including factory investigations and laboratory experiments, were made by Prof. A. F. Stanley Kent, of the University of Bristol, for the British Home Office.[2] They are discussed on pages 39 to 47.

The British Association for the Advancement of Science has also issued two reports on the hours-of-work problem with special reference to accidents, but since these deal largely with American material gathered before the war they are not reviewed in this analysis.

The Health of Munition Workers Committee in the course of its investigation conducted numerous first-hand studies of factory conditions. In January, 1916, however, before these factory studies were completed, the committee issued several preliminary memoranda on Sunday labor, hours of work, and overtime. For many months before these preliminary reports were made, hours of work had been very long, frequently 12 per day for seven days, and sometimes 15 or more daily for six days, with some Sunday work in addition.

SUNDAY LABOR

The committee reported strongly against Sunday labor, and urged that it should be discontinued except for certain necessary work such as tending furnaces, and that in such cases a compensating period of rest should be provided. The report stated that:

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[1] A list of the committee's publications will be found on page 56.

[2] Dr. Kent's studies were commenced before the war.

> Except for quite short periods, continuous work . . . is a profound mistake and does not pay — output is not increased.

In this connection it was stated that employers generally were opposed to Sunday work and that already there was a tendency to reduce or discontinue it.

HOURS OF WORK AND OVERTIME

The committee's preliminary recommendations as to hours of work may be summarized as follows:

> That for men the average hours per week should not exceed 65 to 67, including overtime.
>
> That for boys the hours could be the same as for men, but the committee reached this conclusion reluctantly and urged that boys under sixteen should not be permitted to work more than 60 hours per week.
>
> That for women and girls work hours in excess of the normal limit of 60 per week ought to be discontinued as soon as practicable.
>
> That overtime[1] should not be required on consecutive days, and that where overtime was resorted to it was especially important that there should be no Sunday labor.

In this connection the committee said:

> The limits of hours which they propose are based on the expectation that the War will be of long duration, and are such as they think can reasonably be continued over a protracted period.

Objections to overtime were in substance as follows:

> Overtime is effective only in emergencies. When extended over a long period, the rate of production tends to decrease, neutralizing the results of the extra hours worked;

---

[1] There is no clear statement in the reports as to where overtime begins.

> It frequently results in loss of much time, on account of exhaustion and sickness;
>
> It imposes a serious strain on the management and the foremen both on account of the actual hours worked and the increased anxiety to maintain output;
>
> It is liable to curtail unduly the periods of rest and sleep of those who live far from their work;
>
> The fatigue entailed increases the temptation to use intoxicants.

Fatigue, it was observed, was most noticeable among executives and foremen.

The committee stated that it had not found "that as yet the strain of long hours has caused any serious breakdown among workers, though many general statements indicative of fatigue have been received." It urged, however, that some action must be taken in regard to continuous labor and excessive hours of work if it was desired to secure and maintain maximum output over a long period.

COMMENT ON EIGHT-HOUR DAY

The committee took no definite position as to an eight-hour day. It was stated in a preliminary report:

> While it is no part of the duty of the Committee to express any views on the "eight-hour day" as understood in the Engineering Trades, the system of eight-hour shifts is one that has come very forcibly under their attention. There are undoubtedly certain advantages to be derived from this system of hours. They involve little or no strain upon the workers; the periods during which machinery must stand idle for meals are very much reduced, while significant statements have been put before the Committee claiming beneficial effects upon output. Unfortunately, apart from any other reason, a shortage of workmen and the difficulties of supervision, as well as problems of housing and transit, to a large extent exclude eight-hour shifts from practical consideration, so far as male workers are concerned. The difficulties in the case of women

> are much less, and it is the more important to establish the eight-hour shift, in their case, because there are being attracted into munition works at the present time women who hitherto have been entirely unaccustomed to factory life, and who are on that account not unlikely to find the strain of a twelve-hour day too great, while they could work readily and effectively through an eight-hour period.

Evidently this refers to the system of eight-hour shifts in continuous industries where the choice as a practical matter falls between three eight-hour and two twelve-hour periods. The committee's conclusion in respect to an eight-hour shift for women apparently was not the result of investigation, but an expression of opinion.

The committee further stated:

> There is an extraordinary conflict of opinion as to the number of hours that can profitably be worked. On the one hand the advocate of the 48 hours week is emphatic in his view that this is the maximum a man can be employed effectively. "All overtime is bad," said the representative of one large firm; "we only work if driven to do so by urgent demands from the Ministry, and even then our men become disorganised, and it is doubtful if our output is in any way increased." On the other hand those who are employing their workers for 15 hours a day, sometimes with Sunday work in addition, state with apparently equal confidence that such hours are not excessive, that they have been worked in times of peace, and that they can not be reduced without loss of output. It is noticeable that amongst those in favour of shorter hours are employers who have given the most careful study to the question of industrial fatigue and scientific management, and it is at least significant that, so far as the Committee can learn, no employer who has once adopted the shorter scale of hours ever desires to return to a longer period. If, however, the 48-hours week is to be made a success, the reduction of hours must be accompanied by a reorganisation in factory management, which it would be difficult or impossible to carry out at the present time.

The committee, therefore, while impressed by the experience of some employers with a 48-hour week, regarded its adoption under war conditions as out of the question. It mentions rather than discusses this matter. No specific investigation of the merits of a 48-hour week was made. Incidental experience during the course of the studies indicated a decrease in output in nearly every case where the actual hours of work were as few as 48.[1] Experience during occasional weeks, however, does not throw much light on the problem. There is no evidence in the reports which would warrant conclusions on the subject.[2]

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[1] See also pages 20 and 24.

[2] It seems clear that the committee's discussion of a 48-hour week had reference to an eight-hour day for six days in the week. The distinction should be noted between this and the understanding of an eight-hour day common in some trades in the United States, viz., eight hours of work per day for five days, with a half holiday on Saturday, or 44 hours per week in all.

OUTPUT STUDIES OF HEALTH OF MUNITION WORKERS COMMITTEE

The Health of Munition Workers Committee regarded the study of output as essentially a study of industrial fatigue. That is, changes in output were used as an indication of the degree of fatigue. For the sake of clearness this analysis discusses the relation of hours of work to output directly. The obvious relation between fatigue and output should, however, be kept clearly in mind.

The output studies were made chiefly from routine factory records of selected groups of employees rather than from personal observations. On this point the committee in its interim report remarked:

> The statistical data examined have been those extracted from the wage sheets and other records kept by firms for their own purposes. By this method, however, the advantage has been gained that in no case were the workers aware that the records of their work were likely to be subjected to any unusual scrutiny. The conditions, in fact, were normal and not artificial; the inquiries were in the nature of "field" and not laboratory experiments, and the data gain in value accordingly.

From an examination of the reports, however, it seems clear that the data thus gathered were to some extent supplemented by direct observation.

The principal output studies were conducted by Dr. H. M. Vernon, of Magdalen College, Oxford. Two reports by Dr. Vernon have been published by the committee. The first, dated August, 1916, gave average rates of output for selected groups of workers, engaged in different kinds of labor, under different hours-of-work schedules, over periods of from five to twenty-seven weeks. The second report, dated April, 1917, continued several of the earlier studies and covered a period of about a year.

Certain highly important considerations must be kept in mind in reviewing the reports. For instance, the first report stated:

> The statistical data collected with one exception concern the output of day shifts, and they were collected in large and recently built munition works where the conditions of labour such as lighting, warming, ventilation and the provision of canteens, were as favourable as possible. All classes of operatives were on piecework, they were paid at a high rate of wages, and there were no Trades Union restrictions whatever upon output. Hence there was every possible stimulus for them to exert their maximum powers of production.

There was, therefore, an unusual wage incentive before these workers. They were on a piece-rate basis and wages were high.[1] Furthermore, full assurance was given by the British Government in March, 1915, that piece rates would be maintained.[2] The bearing of such an assurance on output is important. While it does not change the fact that under shorter hours output was at times maintained or even increased, it does raise the question how far this unusual stimulus contributed to the results. For this reason the results reported may not be representative of those likely to be secured where such an unusual incentive is absent. The fact, however, that this assurance was given seven months before the first output studies were commenced shows that this incentive was in effect during the entire period covered by the investigations.

Patriotism likewise may have exerted an important stimulus on production. Certainly this was true of munition production in France.[3]

The statement previously quoted that there were no trade union restrictions upon output was challenged in Great Britain. In his second report Dr. Vernon replied to this criticism at some length. From certain arbitrary tests of a somewhat hypothetical nature he concluded that there was no general restriction, but his reasoning is not altogether convincing, for it is a matter of common knowledge that at the outbreak of the war restrictive rules and customs were practically universal in British industry. If a disposition to restrict production existed at the outset of the studies, but was later abandoned, this would of course increase the difficulty of fairly judging the effect of the reductions in hours.

---

[1] Apparently, however, in some of the later studies part of the workers were employed on a time basis.

[2] This fact was not specifically mentioned in Dr. Vernon's report, but was ascertained by correspondence; such assurance was, however, specifically mentioned in the committee's report on "Incentives to Work, with Special Reference to Wages."

[3] See page 38.

There was a general statement in the second report that collateral conditions, such as type of machinery or methods of operation, were the same throughout the period covered by these studies. In response to a cabled inquiry the committee stated that the speed of machinery had not been altered.

FIRST REPORT ON OUTPUT STUDIES

The essential findings of the first report with respect to output are summarized below; it should be noted that actual hours are given in all cases, and that nominal hours were considerably longer.

For a group of twenty-seven men engaged in heavy labor, an increase in both hourly output and total output accompanied a reduction in actual hours of work from 61.5 to 56.2 per week.

For a group of nine boys engaged in heavy labor, a marked increase in both hourly output and total output followed a reduction in actual hours of work from 68.3 to 60.9 per week.

For a group of twenty-three men engaged in moderately heavy labor, an increase in the actual hours of work from 47.8 to 59.7 per week was accompanied by some decrease in the hourly rate, but by a decided increase in total output.

For another group of twenty-two men engaged in moderately heavy labor, a reduction in actual hours of work from 60.3 to 51.8 per week was accompanied by a substantial increase in the hourly rate and by practically maintained total output.

For a group of one hundred women engaged in moderately heavy labor a reduction in actual hours of work from 68.2 to 59.7 per week was accompanied by a pronounced increase in the hourly rate and by a considerable increase in total output.

For a group of seventeen boys engaged in light labor, a reduction from 75.6 to 59.4 actual hours per week brought only a moderate increase in the hourly output and caused a sharp decrease in total output. Total output under 70.9 actual hours was, however, practically as large as that under 75.6.

For a group of twenty-one women engaged in light labor, a reduction in actual hours from 67.4 to 53.1 per week was followed by a heavy decrease in total output; a subsequent increase to 59.8 hours, however, gave practically the same output as had been obtained from 67.4 hours.

As a result of his early studies Dr. Vernon reached tentative conclusions, in substance as follows:

> For men engaged in the very heavy labour of sizing fuze bodies the actual hours necessary to secure maximum output appeared to be 56 or less per week.
>
> For men engaged in boring the powder chamber and in turning and finishing shells they were probably 60 or rather more.
>
> For men rough-turning shells and for youths boring top caps they were probably 70 or even more.
>
> For women engaged in the moderately heavy labour of turning fuse bodies they were 56 or less.
>
> For women on the light labour of milling a screw thread they were rather over 60 hours.

He further said:

> In so far as time-keeping[1] is a criterion, women and girls on the very light work of gauging fuses appeared to stand even 76 hours fairly well, but it is more than likely that their actual output was little, if any, greater than when they were working 64 hours, and so it is probable that this figure should be regarded as their maximum.

---

[1] *i.e.* attendance at work.

These tentative conclusions were changed as a result of subsequent studies, and therefore need not be discussed at length; in the main, the later studies show that maximum output was attained under somewhat shorter hours.

SECOND REPORT ON OUTPUT STUDIES

The second report was devoted principally to an extension of four of the earlier studies, but covered longer periods and in two cases larger groups of workers.

In issuing the report the committee said:

> The Committee realise that the data at their disposal are not yet ample enough to permit them to express a final judgment upon the whole question of hours of labour in relation to output on the one hand, and the well-being of the employee on the other. But they are strongly of opinion that the evidence collected by Dr. Vernon, and the conclusions he deduces therefrom, merit the immediate and earnest consideration of all concerned in industrial organisation at the present time. Dr. Vernon's investigations are the more valuable in that they were undertaken in a spirit of scientific enquiry, and were not prejudiced by preconceived opinions.

While, therefore, it would appear that the committee was in general sympathy with Dr. Vernon's work it did not specifically commit itself to an endorsement of his conclusions.

The reductions in work hours discussed in the second report were largely due to the abolition of Sunday labor which, in the factories investigated, occurred about July or August, 1916.

Such a cessation of Sunday work may easily have had a greater effect on output than would an equal reduction in hours distributed over six weekdays. The possibility that, as a result of much Sunday labor in addition to extremely long hours, these workers were suffering from excessive fatigue and that their output was below normal, thus giving an exaggerated idea of results likely to be obtained from an equal reduction in hours under ordinary conditions, must also be taken into consideration.

In analyzing the data it is also important to keep in mind at all times the distinction between actual and nominal hours. Frequently there is a wide difference between these, and comparatively short schedules of averaged actual hours often were not the result of a corresponding shortening of the nominal factory work schedules. Instead, weeks of exceptionally short actual hours often were due to a large amount of lost time. For instance, 45 actual hours per week did not mean a nominal schedule close to this figure or even as short as 50 hours. Instead, the nominal schedule of hours during these investigations ranged in the main from 58.5 to 66.5 hours; it was seldom less than 54 hours.[1]

If so large an amount of lost time signified a fatigued condition of the worker it might be argued that output would be less than under normal conditions. If, on the other hand, much time was taken off because high wages had made these workers unusually independent, they may have been in a condition to exert themselves to an exceptional degree on returning to their work. In any case so much lost time makes it difficult to measure the effect of changes in hours and necessarily qualifies any deductions made from the studies.

Women Engaged in Moderately Heavy Labor

One of Dr. Vernon's later studies covered the work of approximately ninety women engaged in turning fuse bodies for a period of rather more than a year. This is described as moderately heavy labor:

> The operatives were standing all day at capstan[2] lathes, and had to subject each fuse body to seven successive boring and cutting operations. These operations required close attention throughout and some delicacy of manipulation, so that no relaxation of effort was permissible during the actual turning.

Dr. Vernon's statistical results are given in Table 1, on page 50. They are briefly summarized below in the form of weekly averages for varying periods, the periods being those used in the original reports. This summary table shows the nominal or factory schedule hours; the actual weekly hours of work, which are arrived at by deducting from the nominal hours time lost by absence, tardiness, and minor interruptions; then the relative hourly output and the indicated total weekly output, which is the product of the average hourly output multiplied by the average actual hours per week.[1] The average hourly output and the total weekly output for the first six weeks period are taken as 100%; subsequent figures are in relative values.

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[1] The nominal schedules are given in the tables in the Appendix, pages 50 to 55.

[2] Turret lathes.

GROUP OF ABOUT NINETY WOMEN TURNING ALUMINUM FUSE BODIES (MODERATELY HEAVY LABOR)

Weeks ending	Average nominal hours per week (approximate)[2]	Average actual hours per week[3]	Average (relative) hourly output	Indicated total weekly output
1915				
Nov. 14—Dec. 19...	74.8	66.2	100	6,620 = 100
1916				
Feb. 27—April 16...	64.3	53.4	123	6,568 = 99
May 14—July 2...	61.2	54.8	134	7,343 = 111
July 9—July 23...	55.6	50.0	132	....
July 30—Aug. 19...	57.0	47.0	124	....
Sept. 2—Sept. 23...	58.0	49.9	135	6,737 = 102
Oct. 7—Nov. 4...	57.7	48.3	144	6,955 = 105
Nov. 11—Dec. 16...	54.8	45.6	158[4]	7,205[4] = 109

The table, on its face, indicates that a reduction in average actual hours from 66.2 per week at the close of 1915 to 54.8 in May and June, 1916, was accompanied by an increase in the average hourly output from 100 to 134. Total output rose from 6,620 to 7,343, an increase of 11%. Hourly output then remained fairly constant for several weeks, but in midsummer there was a sharp decline, which Dr. Vernon is disposed to attribute to the denial of certain customary holidays. To make up for this, a holiday period of a week was given at the end of August and another of several days at the end of September. From the first of September on, hourly output showed a gradual increase, and, with average nominal hours of about 58 per week and average actual hours of about 49, total output in September and October was from 2 to 5% greater than that obtained at the beginning of the studies with 75 nominal and 66 actual hours.

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[1] For convenience the phrase "indicated total output" or "total output" is used in this text rather than "hours of work × relative output" used by Dr. Vernon in his tables. For some groups of weeks Dr. Vernon does not make this calculation. See Table 1, page 50.

[2] Nominal hours were not averaged by Dr. Vernon, but have been averaged here for comparison with actual hours. See Table 1.

[3] The method of computing actual hours of work differs somewhat from that used in the preliminary studies in that total lost time is here deducted by Dr. Vernon, whereas in the earlier report certain extended absences were not taken account of. The present method, if applied to the earlier studies, would, it is stated, have resulted in actual hours of work from two to five hours per week less than were there shown.

[4] This average included results for two weeks before Christmas, when the hourly rate rose to 174 and 179 respectively. These rates, as shown in the text, were apparently abnormal. Excluding these two weeks the average actual hours were 44.1, the hourly average 148 and the total output, 6,527.

Near the close of the year the hourly rate rose to 158 for a six-weeks period, with average actual hours of only 45.6 per week. For this six-weeks period total weekly output was 7,205, or only a little under the maximum previously obtained with 54.8 hours. Dr. Vernon concluded that:

> With good timekeeping, a nominal 50-hour week ought to yield the actual hours of work mentioned,[1] or one may say that *for women engaged in moderately heavy lathe work a 50-hour week yields as good an output as a 66-hour week, and a considerably better one than a 77-hour week.*[2]

This conclusion does not appear to be warranted. The hourly average of 158 for the six-weeks period included results for two weeks shortly before Christmas, when the rates reached 174 and 179 respectively. These rates were so exceptional that they should have been excluded, unless it was found that they were maintained over a longer period, for it is almost certain that some unusual incentive, such as a desire to earn extra Christmas money, led the workers to make an extraordinary effort. Excluding the figures for these two weeks, the total indicated output for the other four would have been only 6,527, which is much below the output previously obtained in 54.8 actual hours. For two weeks ended November 18, 1916, when actual hours averaged 46.5 per week, total output was 6,306 and 6,881 respectively, an average of 6,594, again very much less than that reported by Dr. Vernon for 45.6 actual hours. The exceptional character of the results for the two weeks ended December 16th can be seen from the following table, giving weekly totals, computed from the full table on page 50.

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[1] That is, 45.6 actual hours.

[2] Italics as in original. This statement has reference to nominal hours throughout. See page 29.

Week ending	Actual hours	Hourly rate	Total weekly output
October 7	43.5	137	5,960
October 14	49.2	146	7,183
October 21	52.0	153	7,956
October 28	46.9	132	6,190
November 4	50.0	152	7,600
November 11	44.1	143	6,306
November 18	48.8	141	6,881
November 25	41.8	156	6,521
December 2	41.6	152	6,323
December 9	48.8	174	8,491
December 16	48.8	179	8,735

It seems, therefore, that Dr. Vernon was in error in concluding from such limited data that a 50-hour nominal week (which he argued should yield 45.6 actual hours) would give maximum production.

There was of necessity more or less change in the personnel of the various groups of workers observed during the course of the studies. For instance, in the case of the fuse-turning women, the report states:

> By the end of August, 29 out of the group of 95 operatives had disappeared, but to the remaining 66 were added 14 other workers, or the total block of workers subjected to investigation was now 80 instead of 95. Of these 80 workers 43 were included in the original group, but statistical examination showed that in this particular operation there was no appreciable difference between the output of old experienced workers and of fresh and comparatively inexperienced workers. Hence, as there was no change whatever in the machinery and tools or the nature of the operation, one may regard the output data over the whole 14 months as strictly comparable with one another.

In another report of the committee,[1] Dr. Vernon is quoted as follows:

> The strongest women available were picked out for the work, but many of them could not stand it for more than a few weeks. Of the 95 operatives of whose history I possess an adequate record, 22 gave

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[1] Incentives to Work, with Special Reference to Wages.

> up after four weeks or less, and 11 more after 10 weeks or less, but I have no information as to the cause of their retirement.

A large turnover of labor is, of course, an entirely normal condition, but the shifting of the working force here described introduces an element of uncertainty, although Dr. Vernon contended that by excluding workers who had not attained proficiency he had eliminated the factor of increasing skill.

In discussing the cessation of Sunday work Dr. Vernon said:

> Its abolition had no immediate effect on output. Not until the week ending October 14,[1] or ten weeks after its abolition, can it be said that there was an undoubted increase of output above the May-June level, and this increase did not culminate till eight weeks later. That is to say, the response to the abolition of Sunday work took over four months to reach its full development, so it is evident that any experiment on the effect of alteration of hours must be continued for at least this number of months before definite conclusions can be reached. The reduction of hours from 77 to 66 a week which began on January 24 did not cause any appreciable effect on output for four weeks, and did not produce its maximum response until May 8–14, or 16 weeks later. This slowness in the reaction of output to a reduction of hours indicates very clearly that it occurs unconsciously, and is due to the worker finding gradually, by experience, that she can work more strenuously and quickly for a short-hour week than for a long-hour week.
>
> . . . .
>
> The increased output which follows on a reduction of hours is *not* due, as many works' managers maintain, to the determination of the worker to earn as much wages as she was doing under the longer-hour system, for in such a case she would increase her output immediately the reduction of hours occurred.

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[1] *i.e.* 1916.

As to the influence of holidays he said in his second report:

> In my previous Memorandum (No. 12) I pointed out that the output rose considerably (6% to 11%) for four weeks or more after a holiday had been taken, but when the hours of work are reduced a holiday often has a more important effect than this. The workers, refreshed and more vigorous, unconsciously start work at a higher level of speed, and maintain that higher level permanently, whereas a reduction of hours unaccompanied by a holiday, *i.e.*, by a chance of breaking through settled habits of work, is generally very much slower in producing the desired reaction.

Many of these statements, while interesting, must be regarded merely as opinions, not as demonstrated facts.

Men Engaged in Heavy Labor

Another instance of increased output under a shortening of hours of work is found in the case of a group of fifty-six men engaged in sizing fuse bodies. This was heavy labor, involving much lifting and close application.[1] The detailed table appears on page 54. The results are summarized below.

GROUP OF FIFTY-SIX MEN SIZING FUSE BODIES (HEAVY LABOR)

Weeks ending	Average nominal hours per week (approximate)[2]	Average actual hours per week	Average (relative) hourly output	Indicated total weekly output
1915 Nov. 14—Dec. 19	66.7	58.2	100	5,820 = 100
1916 Feb. 27—April 16	62.8	50.5	122	6,161 = 106
May 28—July 16	60.8	52.1	119	6,200 = 107
July 22—Aug. 5	55.7	46.3	123	....
Sept. 2—Sept. 23	53.8	47.6	135	6,426 = 110
Oct. 7—Nov. 4	54.9	51.3	137	7,028 = 121
Nov. 11—Dec. 16	56.8	51.2	139	7,117 = 122

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[1] The report says:

> In the sizing of fuse bodies the article is usually subjected to four separate operations, in each of which it is clamped to a small fly-wheel and handle and is screwed through a steel tap so as to cut a screw thread on it. The operations require no manual dexterity, but they are a great and continuous strain on the muscles of one arm and shoulder and to a less extent on those of the back.

[2] See footnote 2, page 19.

This table shows an almost uninterrupted rise in hourly and also in total output as actual hours were reduced. Starting at the end of 1915 with the results for a week of 58.2 actual hours as 100, the hourly rate rose to 119 in June and July, 1916, when the actual hours averaged 52.1 per week. Sunday work was abandoned about the middle of July. In the next four weeks hourly output gradually increased. Later, following a week's holiday at the end of August, the rate held fairly constant around 135, advancing somewhat from that level during the next three months. This increase in the hourly rate was sufficient to cause a substantial increase in total output which rose to 7,117, under 51.2 actual hours, near the close of 1916 — a gain of 22% over that previously obtained from 58.2 actual hours.

Commenting on this exhibit the report states:

> The cause of this marked and sudden rise is not certain, but it seems extremely probable that it was due to the abolition of Sunday labour, as no other working condition was changed.
>
> . . . .
>
> The withdrawal of Sunday labour seems to have caused the men to observe much more regular hours, and during these regular hours to increase their hourly output some 16% above its previous level. The total output was thereby increased by no less than 22% above the value reached a year previously. The much more marked response of output to reduction of hours shown in this operation than in the fuze-body-turning operation is probably due to the fact that every movement involved in the sizing can be quickened to an equal degree, and there is practically no limit of speed, whereas in lathe work it is not feasible to increase beyond a certain point the speed with which the cutting and boring tools are applied to the fuze body.

During four weeks in September the average actual hours of work were only 47.6. The hourly rate was not much different from that later shown with 51.2 actual hours; the total output consequently was much less. The total output for these short weeks was, however, considerably better than that obtained in November and December, 1915, under a nominal schedule of nearly 67 hours per week, and actual hours of 58.2 per week.

For this group, then, a week of about 51 actual hours secured maximum production. The nominal hours during this maximum output period generally ranged from about 54.5 to 58.5. The labor, it will be remembered, was heavy.

This study seems to indicate conclusively that the increase in output was due, at least in part, to reduction in working hours. But the amount of the increase is so great as to suggest that some other factor also contributed to the results.

Dr. Vernon constructed a set of hypothetical curves which tended to show, for these men engaged in the heavy labor of sizing fuse bodies, that still further reduction in hours would have resulted in a further increase in output. He may be right, but it is obvious that conclusions on this point should not be based on hypothetical calculations, but only on actual experience.

WOMEN ENGAGED IN LIGHT LABOR

The third study relates to a group of women milling a screw thread, a light, machine process.

The earlier series of observations covering the work of twenty-one women over a period of twenty-seven weeks led Dr.Vernon to conclude that maximum output would be obtained only with a work-week somewhat in excess of 60 actual hours.[1] A continuation of this study for several months, and for the greater part of the time with a group of forty women, however, indicated that maximum output could be obtained under a considerably shorter work-week. The statistical results for the entire period are given in detail in Table 2, on page 52. They may be summarized as follows:

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[1] See page 16.

GROUP OF FORTY WOMEN MILLING A SCREW THREAD (LIGHT LABOR)

Weeks ending	Average nominal hours per week (approximate)[1]	Average actual hours per week	Average (relative) hourly output	Indicated total weekly output
1915				
Nov. 21—Dec. 19......	71.8	64.9	100	6,490 = 100
1916				
Feb. 27—April 16......	62.9	55.4	109	6,039 = 93
May 28—July 9......	61.2	54.6	114	6,224 = 96
July 16—Aug. 6......	64.6	54.8	121	6,631 = 102
Sept. 2—Sept. 23......	50.2	45.5	121	5,506 = 85
Oct. 14—Nov. 18......	57.3	48.1	133	6,397 = 99

Examination of the table shows that for this light work maximum total output — 6,631 — was obtained in a work-week of 54.8 actual hours. This output is 2% greater than that previously obtained from 64.9 actual hours. Moreover, total output obtained in October and November, 1916, with averages of 57.3 nominal hours and 48.1 actual hours per week, was only about 3.5% less than the maximum. But in September, with average actual hours of 45.5 per week, total output fell to 85% of that obtained from 64.9 actual hours.

Commenting on this study, the report states:

> The reason why a reduction of hours did not lead to an actual improvement of total output, as it did in the fuze-body-turning operation, is not far to seek. For four-fifths of the total time required to mill the screw thread on the fuze body the operative had no opportunity of quickening her working speed, as she had to stand idly watching her machine, whereas the lathe worker had to apply seven different cutting and boring tools in succession to each fuze body, and could quicken up her speed of work at almost every stage.

This statement affords a good illustration of the important bearing which the character of the process has on results obtainable from a shortening of hours.

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[1] See footnote 2, page 19.

Boys Engaged in Very Light Labor

The fourth study relates to the very light labor of boring top caps, which was performed by boys. The first report described their work as follows:

> About four times a minute they unclamped one cap and clamped in another, these two clampings together occupying less than two seconds. For the rest of the time they stood at their machines doing nothing.

In the second report it was further stated that this is

> an automatic process which cannot be accelerated. Increase of output could only be attained by a more continuous feeding of the machines throughout working hours.

Detailed results will be found in Table 4, on p. 55. A summary follows:

GROUP OF FIFTEEN YOUTHS BORING TOP CAPS (LIGHT LABOR)

Statistical period	Average nominal hours per week	Average actual hours per week	Average (relative) hourly output	Indicated total weekly output
1915				
Nov. 15—Dec. 19...	78.5	72.5	100	7,250=100
1916				
Jan. 3—Feb. 13...	75.5	69.1	106	7,325=101
Feb. 21—April 16...	63.4	54.8	108	....
May 1—May 28...	61.5	54.7	117	6,400= 88
May 29—July 2...	51.1	47.4	124	.... ..
July 3—Sept. 23...	60.7	54.5	129	7,030= 97
Sept. 25—Dec. 16...	56.5	51.7	126	6,514= 90

It appears, therefore, that for this very light labor maximum output was obtained under a nominal schedule of 75.5 hours (in January–February, 1916) and actual hours of 69.1. However, output later obtained under 54.5 actual hours, with a nominal schedule of about 61 hours, was only about 4% less. But a further reduction to 51.7 actual hours, with nominal hours of 56.5, was accompanied by a sharp decrease in output.

Hourly output, which was taken as 100 when the actual hours were 72.5, rose to 129 with actual hours of 54.5. The report states:

> Cursory observation of the youths boring top caps would suggest that by no possibility could they increase their hourly output however short their hours of work, but the data adduced show that this view is erroneous, and that a more persistent and continuous application to their machines could effect an improvement of 29% or more.

When it is recalled that the operation of boring top caps was almost entirely machine work, that the speed of the machine could not be increased, and that the only opportunity for increasing output was by more continuous feeding of the machine during working hours, an increase of 29% in hourly output is so remarkable as to call for explanation. Dr. Vernon says:

> Sunday work entirely ceased after July 30, and was performed only on two occasions after May 21, but it is not possible to say how much of the maximum output shown from July 3 onwards was due to this abolition of Sunday work.

Evidently, therefore, he was not ready to attribute this increase in hourly rate of output wholly to reduction in work hours. In his summary of conclusions, however, this instance is used to support the general argument that reduction in hours increased hourly output.[1]

While these results are interesting they cannot be fairly attributed merely to a shortening of hours without much more information than is given in the reports as to whether more efficient methods of supervision or similar changes were also introduced at the same time.

SUMMARY

Dr. Vernon's conclusions were in part as follows:

> The group of women (numbering from 80 to 100) engaged in the moderately heavy labour of turning

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[1] See page 29.

aluminum fuze bodies provided the following comparative results:—

(i) When actually working 66.2 hours a week and nominally 74.8 hours their relative hourly production was 100 and their relative gross production 100.

(ii) When actually working 54.8 hours and nominally working from 58.5 to 66 hours their hourly production was 134 and their gross production 111.

(iii) When actually working 45.6 hours and nominally working from 49.5 to 58.5 hours their hourly production was 158 and their gross production 109.

It is therefore to be inferred that had these women been working uniformly a nominal 50-hour week their gross output would have been as large as when they were working a nominal 66-hour week, and considerably greater than when they were working a 77-hour week. In other words, a considerable addition to the leisure time of the operatives would have substantially improved the total output of the factory.

A group of 40 women engaged in the light labour of milling a screw thread on the fuze bodies improved their gross output by 2% when actually working 54.8 hours a week, the standard being their gross output when working 64.9 hours per week. A further reduction of actual working hours to 48.1 resulted in such an improvement of hourly output that the gross output was only 1% less than when the actual working time was 16.8 hours more.

A group of 56 men engaged in the heavy labour of sizing the fuze bodies improved their hourly output by 37% and their gross output by 21% when actually working 51.2 hours, the standards being the hourly and gross outputs observed when the actual weekly hours were 58.2.

Fifteen youths engaged in the light labour of boring top caps by means of automatic machines

> produced only 3% less output when their actual weekly hours of work were 54.5 hours than when they were 72.5 hours.

These conclusions call for careful consideration. The studies indicate definitely that extremely long hours, continued overtime, and Sunday labor are uneconomic. They indicate, further, that reduction of work hours within certain limits does not necessarily decrease output, but on the contrary may, for some classes of labor at least, actually increase it. But in view of the limited scope of the data and the many complicating factors, it cannot be assumed that the percentage increases of output reported are an accurate or even an approximate measure of the results likely to be secured from similar work hours under normal conditions. Even under the most favorable conditions for study, numerous influences other than the length of workday affect the rate of production. In the studies here considered, conditions, as already shown, were in many respects abnormal. The assurance of high wages, the stimulus of the national crisis, abolition of Sunday labor, and, on the other hand, possible restriction of output in the first portion of the observation period and some evidence of a rather low standard of efficiency, all introduce numerous uncertainties into the conclusions.

Certain other collateral conditions, such, for instance, as the actual rates of wages, quality of work, frequency of accidents, extent of labor turnover, and seasonal influences, are not described in such detail as to permit a clear estimate of their possible bearing upon the results. The wide difference between the nominal and the actual hours further complicates the problem.

In brief, the value of the studies lies in broad suggestion rather than in quantitative result. They emphasize the need of a searching and extensive inquiry into the relationship of the length of the workday to output and fatigue under more normal conditions of work where some, at least, of the disturbing factors here involved can be eliminated.

One of the most constructive suggestions contained in the studies is the evidence that wages and wage systems exert a marked influence upon output. The reports pertinently indicate the importance of careful study to determine whether a system of wages can be devised which will afford a strong incentive to the worker on a basis which the employer can afford.

NIGHT WORK

The Health of Munition Workers Committee was opposed to night work, but held that it was necessary in view of war requirements. The reports showed that under "discontinuous" night shifts (*i. e.* alternation, generally weekly, from day to night work) output was practically as large as under day shifts, and in some cases larger. Attendance was better for night shifts, partly, no doubt, owing to the better wages paid.

Continuous night work, however, was definitely less productive than discontinuous. The committee unqualifiedly recommended that, where night work was necessary, the discontinuous system be used.

INDUSTRIAL FATIGUE

The Health of Munition Workers Committee regarded output as the most satisfactory measure of fatigue, which it defined as

> the sum of the results of activity which show themselves in a diminished capacity for doing work.

Fatigue of the worker was compared, not "with the failure of fuel as in a steam-engine, or with the running-down of a clock-weight, but rather with the clogging of the wheels in some mechanism by dirt."

The committee pointed out that:

> It is of vital importance for the proper study of industrial fatigue, however, to recognise not only that bodily sensations are a fallacious guide to the true state of fatigue which may be present, and a wholly inadequate measure of it, but also that fatigue in its true meaning advances progressively, and must be measurable at any stage by a diminished capacity for work, before its signs appear plainly, or at all, in sensation.

This unreliability of symptoms is explained on the ground that industrial fatigue

> is fatigue of the nervous system, though in sensation its effects may be referred to the muscles themselves.

"Even in laborious work," states the report, "it is doubtful whether a man by voluntary effort can cause his muscles to approach advanced fatigue."

While considering output the best test of fatigue, the committee conducted studies of sickness records and made physical examinations of numerous workers. They also suggested a study of accidents and spoiled work as a test of fatigue, but reports so far received contain practically no data on these matters.

The results of the committee's investigations into the health of workers showed, on the whole, surprisingly favorable conditions. The extremely long hours worked in the early stages of the war, it is true, caused an increase in sickness and other evidence of lowered health, particularly where work was heavy in character, and among officials and foremen. With a reduction from exceptionally long hours, however, these evidences of accumulated fatigue were apparently checked. In respect to men, Professor Thomas Loveday, one of the committee's experts, after an investigation covering large numbers of employees, reported that:

> Where hours have been reasonable, and where, having been long, they have been reduced, it seems that, on the whole, sickness has been lower than in normal times, especially among those engaged in light work.

When it is recalled that the war drew from industry a substantial percentage of the most stalwart, and forced the employment of many less robust, this experience is so unexpected as to challenge attention. To some extent it was apparently due to the influence of patriotism. Probably a more important factor was the better scale of living made possible by the relatively high wages paid.

Professor Loveday severely criticized the practice, common in British factories, of working a two-hour period before breakfast. He found that this "early morning quarter" was responsible for a large proportion of the total lost time, and, further, that it was conducive to inferior output. He strongly urged that this early morning work period be abolished, but he called attention to the important point that

> however strong the arguments may be in favour of shorter hours of work, the question of doing away with the early quarter is in principle independent of them, and particularly it ought not to be confounded, as it has often been, with the question of a 48 hours week.

He further contended that overtime was intimately connected with sickness and cited several instances where a large percentage of the hours gained through overtime was lost because of a high sickness rate.

Professor Loveday placed much emphasis upon the faulty character of sickness records and expressed the opinion that the extent of illness was in general much greater than was indicated on the surface.

Another of the committee's experts, Capt. T. H. Agnew, examined the physical condition of about three thousand men and boys.

A summary statement of results follows:

	Men	Boys
Class A (good)	1,198 or 78%	1,374 or 91%
Class B (slightly below normal)	264 or 17%	119 or 8%
Class C (much below normal)	75 or 5%	13 or 1%
Class D (bad)	6 or 0.4%	3 or 0.2%
Total	1,543	1,509

He concluded from more detailed observation that long hours seem to exercise a prejudicial effect upon general health, but he nevertheless reported that:

> It is evident that there is no very gross degree of ill-health prevalent among those at work; the figures suggest a fairly satisfactory position, though the absence of any standard of comparison renders accurate evaluation impossible.

His reports, moreover, indicated that bad factory and housing conditions and long distances traveled from home to factory were in part responsible for such ill-health as he found. Captain Agnew's conclusions, it should be noted, had reference to a workday of such unusual length that the results do not aid much in attempts to measure the effect of ordinary hours-of-work schedules upon health.

HEALTH OF WOMEN WORKERS

The experience in the case of men and boys was substantially duplicated in the records for women which covered about 1,300 workers in eleven typical factories. The report of a board of women physicians who supervised the investigation of the health of women workers, stated:

> The medical findings are on the whole satisfactory. Most of the inspectors had expected to discover far more fatigue directly attributable to the conditions of work, and were agreeably surprised at the general physical condition of the workers.

The report stated that married women with home duties presented an exception to the general rule; these showed marked signs of ill effects of their work. It also raised the question whether the disappearance from factories of workers who had suffered most severely from fatigue might not have led to an understatement of the real extent of illness.

These women physicians expressed the opinion that, as the work continued over a long period and the novelty wore off, the generally favorable conditions found at the time they made their observations would not be maintained. However, they concluded:

> If proper care and forethought are exercised there seems no reason why women and girls, suitably selected and supervised, and working under appropriate conditions, should not take their place in munition factories and carry out many operations hitherto considered fit only for men, without permanent detriment to their future health.

Summary of Sickness Data

Allowing for uncertain factors, such as faulty records of illness and broken time, it nevertheless seems fair to state that the hours observed in British munition factories (ruling out the extremely long hours in force immediately after the commencement of war) had not, up to April, 1917, resulted in a significant impairment of the health of the workers.

In a summary report, the British Health of Munition Workers Committee made the following comment:

> Though evidence was found of strain and fatigue, the reports agree in showing that the great majority of the workers were in good health at the time of their examination, and the medical examiners undoubtedly found less ill-health than they antici-

> pated. It is not easy to determine the principal causes of this absence of serious ill-health or to forecast the extent to which they are likely to continue to be effective, and the investigators evidently have some doubt as to how far they are likely to be so. Patriotism and the better food and clothing obtainable as the result of the higher wages now generally earned have been undoubtedly material factors which may continue to operate. On the other hand, a continuous process of selection of the strongest workers has hitherto been in operation, but must be gradually restricted as the demands on labour increase; thus an endeavour to re-examine after six months the women previously examined at one factory showed that nearly half had left the employment of the firm. It cannot be assumed that because no serious breakdown in health has yet occurred the risk of future breakdown is negligible.

REST PERIODS

All the British investigators attached much importance to the value of rest periods within the workday. Such rest periods, it was contended, should be carefully arranged and regulated and not left to the inclination of the individual worker. Various experiences are cited where the introduction of short rest periods, in some cases at frequent intervals, increased output. For instance, in one munitions factory, where men engaged in the heavy work of molding were required by the management to rest fifteen minutes in every hour of work, the committee found that

> the manager was satisfied that this was an arrangement good for the men and for the output. But the men objected to this long spell of rest in each hour because the work was piece-work, and they thought the production would be lessened by it. The manager accordingly found it necessary to set a foreman to watch and to make the hourly rest compulsory. When this was done the output per hour was found to be actually increased.
>
> At another munitions factory the Committee learnt that the manager had given a break of 15 minutes

> daily at 11 A. M. to girls engaged in sedentary work of a monotonous repetitive kind. During the break the girls had recreation in the open air. In spite of this deduction from their working hours of the time so spent, the output per day was increased.

Rest pauses were regarded by the committee as especially important for women. The committee said:

> Pauses, well distributed and adapted in length to the needs of women workers, are of the highest value in averting breakdown and in giving an impetus to output. The Factory Acts permit in textile factories a maximum of four and a half hours continuous work; in non-textile the limit is five, but many managers believe that four hours is the longest period during which a woman can maintain continuous work at full vigour. Within this period a pause of 10 minutes has been found to give excellent results, and where the spell is continued for five hours some such pause should certainly be made for a cup of tea or cocoa.

Practically all the investigators laid great emphasis upon the evil effects of Sunday labor. Sunday work was greatly reduced in munitions factories during the course of the war, and in April, 1917, it was forbidden in both government and "controlled" plants by statutory order.

The Health of Munition Workers Committee urged that the usual holidays should not be omitted. Furthermore in one of its earlier reports the committee said:

> Proper attention earlier in the War to the need for weekly rest would have prevented a large part of the diminished capacity of this kind that has been allowed to appear, and would have averted much costly and wasteful expenditure upon imperfect work. But stress must be laid here on a further point. For the avoidance of staleness in conditions of strenuous labour it is not enough to treat workmen in the bulk and to regulate daily and weekly rests upon a physiological basis devised for the average. If that be done, widespread evils like those too commonly present now may be

avoided, but good management will consider always the individual workman as well. The Committee have no doubt that in very many cases, perhaps in almost all, in which staleness is well marked or has even advanced to definite sickness, a single "day off," given occasionally at the right time, would have avoided much wasteful reduction of capacity and in the worst cases the total loss of many days of work.

HOURS OF WORK IN FRENCH MUNITION FACTORIES

Mention may be made of a report upon conditions in France, submitted by a British mission which visited that country late in 1915. This mission reported that, despite extraordinarily long hours in French munition factories and much Sunday work, it found no evidence of fatigue due to excessive hours. It attributed increased production to a single cause, the patriotic enthusiasm of the French people. While this is a magnificent tribute, the fact that patriotism was so important a factor prevents use of the results (which were not given in detail) as a criterion of those likely to be obtained under equally long hours in ordinary times.

REPORTS OF PROF. A. F. STANLEY KENT

The reports made by Professor A. F. Stanley Kent to the British Home Office are of little practical value in a consideration of the proper length of workday. They relate to such small groups of workers and such brief periods of time that they could not, in any case, be considered conclusive. In addition, they frequently are inaccurate, while some of the comparisons used are irrelevant.

One of Professor Kent's most important studies was a comparison of the work of one winder in a textile factory, ostensibly working eight hours per day, with that of three others working twelve hours per day. This was used to illustrate the efficiency of the shorter day. Records for only a single individual would, at best, be inconclusive as evidence of the relative efficiency of different hours-of-work schedules. In this case it appears that there were such inequalities in the natural capacity or skill of the different workers that the results are not only inconclusive but misleading. This is indicated by the following table which gives the individual hourly rates of output for the group of winders observed, for a period of one week.

AVERAGE RATE PER ACTUAL HOUR FOR EACH WORKER FOR EACH PERIOD OF THE DAY AND FOR ALL PERIODS

	1st period 6 A.M. to 8 A.M.	2d period 8.30 A.M. to 12.30 P.M.	3d period 1.30 P.M. to 5.30 P.M.	4th period 6 P.M. to 8 P.M.	All periods	Rank of workers in order of rate of output
No. 14A.....	253.0	366.0	347.2	315.0	315.8	1
No. 11......	179.7	305.6	348.4	294.7	282.1	2
No. 12......	251.5	309.4	278.5	240.5	269.9	3
No. 14......	251.3	253.6	252.8	236.7	248.6	4
No. 14B	255.7	198.2	219.4	271.0	236.0	5
No. 10......	193.0	250.0	234.8	204.3	220.5	6
No. 8.......	173.3	219.2	231.4	218.2	210.5	7
No. 13......	177.7	220.8	210.8	208.5	204.4	8
Average.....	214.6	265.4	265.4	248.6	248.5	

The so-called eight-hour worker was No. 14A who, it will be seen, ranked first in the group of eight. The three with whom she was compared were Nos. 10, 8, and 13 respectively; these ranked 6, 7, and 8 in the group with respect to rate of output. The rate of No. 14A is 27% above the average of the whole group, while the average of the other three is 14.7% below the group average; No. 14A's average is 49% above the average of the three with whom she was compared.

Professor Kent argued that the high rate attained by No. 14A was due to the fact that she worked short hours. While it is entirely probable that this was a contributing factor, a difference of 49% indicates that some other influence was largely responsible for the results recorded. In this connection it may be observed that No. 14A was thirty-two years of age, while of her three companions, two were twenty-one and one sixteen; that she had had seventeen years experience as a winder, while of the other three, one had worked four years (only two, however, as a winder), another four years (how much of this at winding is not stated), and the other six years in various departments of the mill.

Professor Kent, in reply to an inquiry on this point,[1] contended that winding is an occupation in which age and length of experience have very little to do with output, and noted that the second most rapid worker of the group, No. 11, was only seventeen years old and had worked only two years in the factory. Nevertheless, the natural presumption would be that a worker thirty-two years of age, who had had seventeen years experience, would be more skillful than the three less experienced workers. Whether or not this is the case is, however, immaterial. The mere fact that she *may* have been more skillful makes it unsafe to base any broad deductions on the comparison. Results for a single worker would be of little value, even if related merely to her own work under workdays of different length. When compared with the work of other operatives they are practically useless as an indication of the merits of a given hours-of-work schedule.

Moreover, the report itself states:

> All of the workers . . . occasionally had the as-

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[1] The principal exceptions to Professor Kent's findings, noted in this chapter, were submitted to the British Home Office for explanation, and referred by it to Professor Kent.

> sistance of young girls learning to "wind," called "helpers." Probably No. 14A had rather more such assistance than the other members of the group.

This doubtless explains some of the marked differences in rates of output, but can in no way justify comparison of the output of 14A with that of the three slowest workers as a measure of the effect of hours of work. Such a comparison is like comparing a race horse with a team of drays and has almost no bearing whatever on the proper length of the workday.

Furthermore, it is not clear that the comparison is really one of an eight-hour worker with twelve-hour workers. The report states that this rapid worker usually worked eight hours per day but shows that on several days during the test she worked 10 or 12 hours. In reply to the question whether, in view of this fact, she could fairly be considered an eight-hour worker Professor Kent stated:

> So far from it being the regular practice of No. 14A to work for more than eight hours a day, an examination of a continuous period of twenty working days, including Saturdays, shows that the average daily hours worked were no more than 7.2, whilst if only fifteen days falling within the experimental periods dealt with are included, the figure is 7.0.

Evidently these hours are arrived at by deducting lost time. Details on this point for the individual workers are given in the report for only one week. Actual hours of the four workers for that period were as follows:

Worker	*Actual Hours*
14A	51.1
10	55.7
13	54.1
8	54.9

These figures suggest very pertinently that if No. 14A can be considered an eight-hour worker, then the three other workers cannot fairly be classed as twelve-hour workers. The comparatively small difference in actual hours is a further indication that 14A's high rate of output was chiefly due to considerations other than the length of the workday.

Although complete data, if available, would change the foregoing figures somewhat, the entire observation period was so short (only twenty-five days) that this criticism would not be invalidated.

Another comparison made by Professor Kent was that of the output of the three slow winders when working 10 hours per day with their output when working 12 hours per day, from which he concluded that under the shorter day production increased by more than 5%. The report says:

> If the weekly totals be collected, the grand total for the two weeks when overtime was worked is (when corrected for lost time) 67,743. The grand total for the two weeks after overtime had been abolished (similarly corrected) is 71,182.
>
> The difference is rather more than 5 per cent. in favour of the latter period.
>
> Thus, a diminution of 16.6 per cent. in the length of the working day resulted in an absolute increase in the output of over 5 per cent.

An examination of various tables in the report, however, indicated that the period during which the work schedule was 12 hours embraced only eleven days, whereas the second period, when hours were reduced to 10 per day, included twelve days, two Saturdays being included in each period. When correction was made for this apparent omission of one entire day in the 12-hour period, it appeared that, instead of an increase of 5% in output under the 10-hour day, there was a decrease of about 5.5%.

The question whether one day was thus omitted was submitted to Professor Kent. In reply he said in part:

> The "weeks" referred to here were, as a matter of fact, not ordinary weeks, but were periods determined by the date of the payment of wages. That the figures are accurate appears certain. They were calculated by one observer, checked by another, and passed in as accurate. They were

> sent back in proof for confirmation, and finally returned accompanied by a note to the effect that "The figures as printed are correct." . . .
>
> Those responsible for the calculations have re-examined the figures, and have expressed themselves as satisfied that the results are correct.

He further stated that a different grouping of days was used in his computation than that suggested by the table in the report to which his conclusion was attached.

However, it is unnecessary to discuss this point further, for in his reply Professor Kent made the following statement:

> Time "lost" by a worker through absence from the mill leads in the first place to a lessening of total output taken over a period of time by the amount which would have been produced by the worker in the time "lost." But since the time has not been spent in labour but in some other manner the worker is or may be in a state different from the normal (the state he would have been in had the absence not occurred) when the next period of labour is commenced. This state will depend upon the manner in which the time "lost" at the mill was, in fact, employed. It will usually have been devoted to some occupation less exhausting than mill labour, and consequently the worker will commence the next shift in a condition of greater vigour than would have been the case had he worked as usual.
>
> This condition of greater vigour will result in an output greater than normal in the succeeding period.
>
> Should an attempt be made to compensate for the time lost by adding to the total output for, *e.g.* the week, the amount which would have resulted had the time not been lost, the total for the week will be too great by the amount of the excess over the normal produced in the period subsequent to the absence. A new correction thus becomes necessary, and its amount depends upon the pro-

> portionate response of the individual to the period of (partial) rest. It depends further upon the period of the day during which the absence occurred. For not only do the different periods of the day differ in their influence in producing fatigue, but the after effect of an absence in one period differs from the after effect of an absence in another period accordingly. And an absence extending over a whole day has effects of its own.
>
> Nor is this all. It is almost invariably found that an anticipated holiday has a marked effect upon the work of the employees in the periods immediately preceding the holiday. And a premeditated, and therefore anticipated, absence from work has a like effect.
>
> To ensure perfect correction it would be necessary to allow something for each of these.
>
> Thus, the correction for "lost time" is a matter of exceptional difficulty, and such correction can only be made approximately. An absence from work disturbs the normal rhythm of the worker, and produces results, not only in the period in which it occurs, but also in those which follow, and in some cases in those which precede, the absence.
>
> In the case under consideration a further correction became necessary when a winder passed from one class of work to another—for instance, from winding a fine yarn to one that was coarser.

The statement "a further correction became necessary" apparently means that arbitrary adjustments were made for the various intangible influences enumerated above. Figures "corrected" on any such basis are of no scientific value in determining the relation of hours of work to output.

Again, Professor Kent compared the output of the three winders for the two middle periods of the workday (from 8.30 A.M. to 12.30 P.M. and from 1.30 P.M. to 5.30 P.M.) during a week when they also worked from six to eight in the morning, with their output for these same middle periods of the day in a subsequent week when the early morning period was suspended. The average daily output for the three workers in the middle day periods when the morning hours were also worked was given as 5,006 bobbins, and the average daily output during the week when there was no early morning period as 5,630 bobbins. The report continues:

> Thus a diminution of 20 per cent in the length of a day of ten hours increased output in the remaining hours by 12.4 per cent.
>
> It is probable that some of the improvement in the above experiment was due to the fact that the workers were able to take a properly-cooked breakfast before leaving home in the morning.

It should be noted, however, that the *total* output obtained from eight hours of work was considerably smaller than that obtained in 10 hours. In order to offset a shortening of 20% in the length of the day a much greater increase in product for the eight-hour period than was here attained would be necessary.

A careful scrutiny of the report, moreover, showed that in the first week (that is, when the two-hour morning period was worked) one of these workers was absent an entire afternoon and her output in the forenoon of that day was relatively low. As a result, her total output for that entire day was only 630 bobbins, whereas for the corresponding day of the next week, when only the two middle periods were worked, it was 2,190 bobbins. The difference of 1,560 bobbins undoubtedly was due in the main to the absence of this worker in the first period.

In so far as the indicated increase in hourly output under the shorter day may have been due to improvement in the food of the workers, conclusions as to the effect of shorter hours would, of course, be further invalidated.

The foregoing instances of careless work throw doubt upon the value of all of Professor Kent's results. Groups which are not fairly comparable were compared; certain necessary adjustments in computations were not made; some of the adjustments which were made appear to have been extremely arbitrary; in general, his conclusions are drawn from very inadequate data. For purposes of scientific study, therefore, his results are practically valueless and in certain respects misleading.

It would be unnecessary to refer to his comparisons at any length had not the report been quoted repeatedly as an illustration of the efficiency of an eight-hour day. As a matter of fact it could more fairly be used to prove the inefficiency of such a workday. There is no intention, however, of so using it in this analysis.

Professor Kent also made certain laboratory studies of "associated" fatigue. These laboratory tests were based on the assumption that fatigue in certain parts of the organism affects the condition of the whole nervous system. For instance, according to this theory, the process of lifting a weight, if continued to the point of fatigue, would cause a sympathetic dimming of the eyesight. The methods employed by Professor Kent, aside from systolic blood-pressure, were:

1. *Complex Reaction Time Test.* Letter or color test. This test was made by requiring the examinee to depress a particular key which, at the instant that its movement was recorded on a moving drum, caused a shutter to fall, exposing one of a series of letters or, in the case of the color test, a particular color. Upon recognition of the letter or color exposed, the examinee selected and depressed the one of six keys in front of him which bore a similar letter or color. This resulted in a second mark on the drum. A chronograph marking fractions of seconds on the drum made it possible to measure the time elapsing between the depression of the first and second key.

2. *Acuity of Hearing Test.* This test was made by determining the greatest distance at which the examinee could hear the ticking of a watch.

3. *Acuity of Sight Test.* This test was made by determining the greatest distance at which the examinee could identify letters of a standard size stenciled on cards.

These tests were made in the morning and again in the evening on various days and differences in results recorded and averaged.

On account of the small number of subjects reported on, and frequent conflict in the results obtained, it is unprofitable to enter into detailed discussion of these laboratory studies. The results by no means invalidate the underlying theory of the tests, but in themselves they cannot be accepted as conclusive. This general opinion, it may be noted, concurs with that of the British Health of Munition Workers Committee, which said in this connection:

> Prof. Stanley Kent has communicated recently to the Home Office the results of some preliminary experiments in this connection. He has inquired whether fatigue due to industrial work shows its effects in associated changes of nervous functions not directly employed in it, as for instance in diminishing the quickness of response to signals, in blunting the acuity of hearing, or the acuity of vision, or in lowering other nervous functions. His general findings are sufficient to show that these indirect associated results of fatigue provide no regular and trustworthy index of the primary fatigue. They give indications, but irregularly in some cases and not at all in others, that the general "tone" of the nervous system is depreciated after a day's work, and declines also during a week's work.

The Health of Munition Workers Committee is conducting laboratory tests of associated fatigue, but thus far the results of its experiments are not available.

Appendix

The detailed tables compiled by Dr. Vernon, which were summarized on pages 19, 23, 26, and 27 respectively of this analysis, follow:

TABLE 1. Output of about Ninety Women

Week ending	Nominal hours of work per week[1]	Per cent of time lost per week as				Actual hours of work per week	
		Broken time	Short weeks	Absent weeks	Total		
1915 Nov. 14—Dec. 19	**74.8**	8.2	2.1	1.3	11.6	66.2	
1916 Feb. 27—April 16	**64.3**	5.9	6.0	5.1	17.0	53.4	
May 14.........	58.5	5.4	2.6	3.0	11.0	55.8	54.8
“ 21.........	**66.5**					58.5	
“ 28.........	**66.5**					56.1	
June 4.........	**66.5**					59.1	
“ 11.........	58.5					51.0	
“ 18.........	58.5					50.3	
“ 25.........	58.5					53.1	
July 2.........	58.5					54.2	
“ 9.........	62.5	4.6	3.9	1.1	9.6	56.0	50.0
“ 16.........	52.5					48.5	
“ 23.........	51.0					45.6	
“ 30.........	**66.5**	7.1	7.1	3.3	17.5	56.2	47.0
August 6.......	**62.5**					48.6	
“ 12	49.5					40.3	
“ 19	49.5					43.0	
“ 26.......	—	—	—	—	—	—	
September 2....	58.5	5.8	5.5	2.6	13.9	48.6	49.9
“ 9....	58.5					51.3	
“ 16....	58.5					52.6	
“ 23....	56.5					47.2	
“ 30....	29.5	—	—	—	—	24.0	
October 7......	58.5	6.0	7.5	2.8	16.3	43.5	48.3
“ 14......	58.5					49.2	
“ 21......	58.5					52.0	
“ 28......	54.5					46.9	
November 4....	58.5					50.0	
“ 11....	53.5	6.5	8.3	2.0	16.8	44.1	45.6
“ 18....	58.5					48.8	
“ 25....	50.0					41.8	
December 2.....	49.5					41.6	
“ 9.....	58.5					48.8	
“ 16.....	58.5					48.8	
“ 23.....	29.5	—	—	—	—	24.5	

1. Boldface figures denote weeks in which there was Sunday labor.

Turning Aluminum Fuze Bodies

Relative output per working hour		Hours of work × relative output	Remarks Concerning Output [By Dr. Vernon]
	100	6,620 (=100)	
	123	6,568 (= 99)	Total output only 1 per cent. less than in pre-Christmas period, though weekly hours of work are 12.8 less.
130 128 132 136 137 142 133 133	134	7,343 (=111)	Total output reaches a maximum, 11 per cent. greater than that of pre-Christmas period, though weekly hours of work are 11.4 less.
126 134 135	132	—	Workers went on to night shift for three weeks.
128 122 126 121	124	—	Fall of output may be due to slackness resultant on deprivation of usual holiday. No more Sunday labour after August 6th.
—		—	Holiday for a week (to compensate for loss of Whitsuntide and August holidays).
136 133 128 143	135	6,737 (=102)	Hourly output rises again to that of the May–June period, but abolition of Sunday labour has not yet had any obvious effect.
136		—	Further four days' holiday (general holiday, by Government order).
137 146 153 132 152	144	6,955 (=105)	Further rise of hourly output due to holiday and to abolition of Sunday labour.
143 141 156 152 174 179	158	7,205 (=109)	Influence of shorter hours and of abolition of Sunday labour now well established. Total output 9 per cent. greater than it was a year ago, though weekly hours of work are 20.6 less.
149			

TABLE 2. Output of Forty

Week ending	Nominal hours of work per week[1]	Per cent of time lost per week as				Actual hours of work per week	
		Broken time	Short weeks	Absent weeks	Total		
1915 Nov. 21—Dec. 19	**71.8**	5.9	1.3	2.4	9.6		64.9
1916 Feb. 27—April 16	**62.9**	5.9	4.1	1.7	11.7		55.4
May 28.........	**66.5**	4.9	4.3	1.6	10.8	62.5	54.6
June 4	**66.5**					63.1	
“ 11.........	55.0					46.6	
“ 18.........	55.0					46.3	
“ 25.........	56.5					51.9	
July 2.........	**66.5**					56.8	
“ 9.........	**62.0**					54.8	
“ 16.........	**66.5**	7.1	5.5	2.6	15.2	59.8	54.8
“ 23.........	**66.5**					55.6	
“ 30.........	**66.5**					53.5	
August 6.......	**59.0**					50.5	
“ 12.......	33.5	—	—	—	—	29.5	
“ 19.......	44.5	—	—	—	—	38.1	
“ 26.......	—	—	—	—	—	—	
September 2....	57.0	5.2	3.5	0.7	9.4	51.1	45.5
“ 9....	51.0					47.5	
“ 16....	44.5					38.5	
“ 23....	48.5					45.0	
“ 30....	29.5	—	—	—	—	26.4	
October 7....	54.5	—	—	—	—	44.8	
“ 14......	54.5	6.2	7.9	2.0	16.1	49.3	48.1
“ 21......	58.5					48.7	
“ 28......	55.5					49.5	
November 4....	58.5					49.9	
“ 11....	58.5					43.1	
“ 18....	58.5					48.3	

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[1] Boldface figures denote weeks in which there was Sunday labor.

Women Milling a Screw Thread

Relative output per working hour	Hours of work × relative output	REMARKS CONCERNING OUTPUT [BY DR. VERNON]
100	6,490 (=100)	
109	6,039 (=93)	
113 111 118 113 118 114 109 } 114	6,224 (=96)	
118 122 119 127 } 121	6,631 (=102)	Total output reaches its maximum, 2 per cent. more than in November–December period, though weekly hours of work are 10.1 less.
123 122	— —	} Reduction of hours owing to temporary shortage of material.
—	—	Holiday for a week.
121 126 117 121 } 121	5,506 (=85)	No immediate response to abolition of Sunday labour, so total output falls considerably.
119 110		
132 132 139 130 134 129 } 133	6,397 (=99)	Total output only 1 per cent. less than in November—December period, though weekly hours of work are 16.8 less.

TABLE 3. Output of Fifty-six Men Sizing Fuze Bodies

Week ending	Nominal hours of work per week[1]	Per cent of time lost per week as				Actual hours of work per week		Relative output per working hour		Hours of work × relative output
		Broken time	Short weeks	Absent weeks	Total					
1915										
Nov. 14—Dec. 19	**66.7**	4.4	5.6	2.8	12.8	58.2		100		5,820 (=100)
1916										
Feb. 27—April 16	**62.8**	5.2	8.6	5.8	19.6	50.5		122		6,161 (=106)
May 28	**66.5**	5.2	8.3	0.9	14.4	54.9	52.1	117	119	6,200 (=107)
June 4	**63.5**					55.8		122		
" 11	58.5					49.9		118		
" 18	53.5					46.0		119		
" 25	58.5					51.2		122		
July 2	58.5					48.3		118		
" 9	**61.0**					51.7		112		
" 16	**66.5**					59.1		120		
" 22	55.5	5.2	9.0	2.7	16.9	47.6	46.3	119	123	
" 29	58.5					45.9		124		
August 5	53.2					45.3		126		
" 12	31.0					27.8		130		
" 19	39.5					33.0		136		
" 26										
September 2	58.5	5.6	4.8	1.1	11.5	51.6	47.6	131	135	6,426 (=110)
" 9	58.5					49.2		135		
" 16	44.5					40.1		133		
" 23	53.5					49.4		139		
" 30	29.5					28.2		135		
October 7	54.5	4.1	1.6	0.9	6.6	51.3	51.3	133	137	7,028 (=121)
" 14	54.5					51.4		142		
" 21	55.3					50.2		138		
" 28	51.8					47.7		133		
November 4	58.5					55.7		138		
" 11	58.5	4.2	5.0	0.7	9.9	53.3	51.2	138	139	7,117 (=122)
" 18	56.0					50.6		136		
" 25	55.2					50.7		135		
December 2	54.5					49.1		140		
" 9	58.5					50.6		141		
" 16	58.5					53.0		146		
" 23	29.5					27.1		136		

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[1] Boldface figures denote weeks in which there was Sunday labor.

TABLE 4. Output of Fifteen Youths Boring Top Caps

Statistical period	Weeks in which Sunday labour was performed	Nominal hrs. of work per week	Per cent of time lost as				Actual hours of work per week	Relative output per working hour	Hours of work × relative output
			Broken time	Short weeks	Absent weeks	Total			
1915 Nov. 15—Dec. 19	5 out of 5	78.5	3.6	0.0	4.0	7.6	72.5	100	7,250 (=100)
1916 Jan. 3—Feb. 13	4 " " 6	75.5	5.8	1.7	1.0	8.5	69.1	106	7,325 (=101)
Feb. 21—April 16	6 " " 8	63.4	5.4	5.8	2.3	13.5	54.8	108	6,400 (=88)
May 1—May 28	2 " " 4	61.5	5.8	2.3	3.0	11.1	54.7	117	
May 29—July 2	0 " " 5	51.1	1.9	5.3	0.0	7.2	47.4	124	
July 3—Sept. 23 (day shift)	2 " " 6	59.7	5.5	3.9	2.2	11.6	52.8 } 54.5	129 } 129	7,030 (=97)
July 2—Sept. 23 (night shift)	0 " " 6	61.6	2.6	4.8	1.4	8.8	56.2	128	
Sept. 25—Dec. 16 (day shift)	0 " " 6	54.8	3.7	7.3	0.0	11.0	48.7 } 51.7	126 } 126	6,514 (=90)
Sept. 24—Dec. 16 (night shift)	0 " " 6	58.2	2.7	0.0	3.3	6.0	54.7	126	

HEALTH OF MUNITION WORKERS COMMITTEE

The committee was appointed by the Minister of Munitions, with the concurrence of the Home Secretary, "to consider and advise on questions of industrial fatigue, hours of labour, and other matters affecting the personal health and physical efficiency of workers in munitions factories and workshops."

The members of the committee are:

Sir George Newman, M.D. (Chairman).
Sir Thomas Barlow, Bart., K.C.V.O., M.D., F.R.S.
G. Bellhouse, Factory Department, Home Office.
Prof. A. E. Boycott, M.D., F.R.S.
J. R. Clynes, M.P.
E. L. Collis, M.B., Factory Department, Home Office.
W. M. Fletcher, M.D., F.R.S., Secretary of Medical Research Committee.
Leonard E. Hill, M.B., F.R.S.
Samuel Osborn, J.P., Sheffield.
Miss R. E. Squire, Factory Department, Home Office.
Mrs. H. J. Tennant.
E. H. Pelham (Secretary).

The following Memoranda have been prepared by the committee:

No. 1. Sunday Labour.
No. 2. Welfare Supervision.
No. 3. Industrial Canteens.
No. 4. Employment of Women.
No. 5. Hours of Work.
No. 6. Canteen Construction and Equipment (Appendix to No. 3).
No. 7. Industrial Fatigue and its Causes.
No. 8. Special Industrial Diseases.
No. 9. Ventilation and Lighting of Munition Factories and Workshops.
No. 10. Sickness and Injury.
No. 11. Investigation of Workers' Food and Suggestions as to Dietary.
No. 12. Statistical Information Concerning Output in Relation to Hours of Work.

No. 13. Juvenile Employment.
No. 14. Washing Facilities and Baths.
No. 15. The Effect of Industrial Conditions upon Eyesight.
No. 16. Medical Certificates for Munition Workers.
No. 17. Health and Welfare of Munition Workers Outside the Factory.
No. 18. Further Statistical Information Concerning Output in Relation to Hours of Work, with Special Reference to the Influence of Sunday Labour.

Interim Report — Industrial Efficiency and Fatigue.